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ORIGINAL ARTICLE

Situation report (SITREP) visualization for effective management of disaster incidents in Sri Lanka

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ABSTRACT

During and after any disaster, a situation report (SITREP) is prepared, based on the Daily Incident Updates (DIU), as an initial decision support information base. It is observed that the decision support system and best practices are not optimized through the available formal reporting on disaster incidents. The rapidly evolving situation, misunderstood terms, inaccurate data and delivery delays of DIU are challenges to the daily SITREP. Multiple stakeholders stipulated with different tasks should be properly understood for the SITREP to initiate relevant response tasks. To fill this research gap, this paper identifies the weaknesses of the current practice and discusses the upgrading of the incident-reporting process using a freely available software tool, enabling further visualization, and producing a comprehensive timely output to share among the stakeholders. In this case, "Power-BI" (a data visualization software) is used as a 360-degree view of useful metrics—in a single place, with real-time updates while being available on all devices for operational decision-making. When a dataset is transformed into several analytical reports and dashboards, it can be easily shared with the target users and action groups. This article analyzed two sources of data, namely the Disaster Management Center (DMC) and the National Disaster Relief Service Center (NDRSC) of Sri Lanka. Senior managers of disaster emergencies were interviewed and explored social media to develop a scheme of best practices for disaster reporting, starting from just before the occurrence, and

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following the unfolding sequence of the disasters. Using a variety of remotely acquired imageries, rapid mapping, grading, and delineating impacts of natural disasters, were made available to concerned users.

KEYWORDS

Daily Incident Updates (DIU); disasters; Power-BI; situation report (SITREP)

1. Introduction

Hydro-meteorological disasters can result in significant damage to human lives and properties. The statistics show around 80% of the disaster events in the world that cause fatalities are hydrological or meteorological disasters (Paul et al., 2018). These hydro-meteorological disasters may result in severe flood situations, landslides, cyclones, etc. Daily Incident Updates (DIU) are formal recordings of the facts relating to an incident that requires an immediate response, and a tool used to capture an unexpected occurrence of hazardous incidents (SafetyCulture, 2021). Such incidents may involve injuries and near misses, health and safety issues, equipment and property damages, etc. An incident update contains the most up-to-date and accurate information that is authenticated at the time of its compilation and is used to determine the allocation of resources following a disaster incident (Officials' Committee for Domestic and External Security Coordination, 2019). This is crucial due to constraints of time, access, distance and other factors to monitor the appropriateness and effectiveness of the responses. When multiple incidents occur at the same time and demands additional capabilities, effective visual incident information system is needed (Jensen, 2020). Accordingly, the study provides the specific information about the problem and solution for the future improvement.

For the purpose of perception and understanding, a data visualization dashboard is useful at every level of the respondents and stakeholders from the operational staff to the command staff and vice versa. Visualization plays a crucial role in the human information sphere and decision-making by memorizing and recalling data more effectively, to enable effective communication during emergencies (Zheng, 2017). Choosing the appropriate visualization for a set of data through visual appeal or graphic design can improve any report, presentation, or dashboard (Zheng, 2017). To enhance the efficient coordination among the stakeholder agencies (local government, national and international organizations, and civil society), parallel communication of the evolving situation is required (with the operational planning and logistic staff of the stakeholders) before, during, and after a disaster (Beaven et al., 2016; Sobhaninejad et al., 2011; Tanzi et al., 2014). Timely dissemination of such information is important to save lives, by facilitating smooth relief and rehabilitation processes. Moreover, the role of the news and social media is crucial during such emergencies (Abedin and Babar, 2018; Houston et al., 2015; Neubaum et al., 2014; Sreedharan et al., 2019; Wiederhold, 2013). Therefore, they should be involved in resolving the disaster response issues.

After an incident occurred, a preliminary investigation has to be conducted and communicated through a DIU within the shortest possible time, while keeping an avenue for periodic updates on the incident. The DIU includes the location of the incident, a list of affected people and properties, casualties and their severity, a description of the immediate measures taken in response, and any anomalies that might have contributed to the particular incident (Officials' Committee for Domestic and External Security Coordination, 2019). Hardly any research publications were found to discuss the importance of the SITREP and related improvement in the country. Further information about the actions of the respondents, during panic situations, is not available. While some examples of situation reports from literature are found from international donor agencies or state agencies, SITREPS for whole countries, and discussions to improve SITREPS are difficult to find. This paper addresses that need. The SITREP processes electronic versions such as annexed video clips, for real-time information, creating further up-to-date information on an evolving incident (Disaster Management Centre, 2017). Visualized user-friendly concise reports result in an easy understanding of the disaster incident and maintain the consistency of the reporting mechanism at all response levels. Based on the severity of the incident, SITREP needs to be shared with regulatory agencies and media as appropriate. The key element is to ensure, all the facts and necessary details are completed and properly validated. Hence, SITREP typically displays numbers and texts, geared toward people who need data rather than a direct understanding or interpretation. For proper visualization, a typical set of data and information are arranged in detailed defined layouts, tabular formats, etc., with simple analysis (by sorting, calculating, filtering, grouping, formatting, and transformation). Visual reports are interactive, with dashboards in some practical cases such as deciding the most affected geographic area to deploy SAR teams and critical resources at a higher National level. Visualization products have been evolving fast and generally fall into a few categories. Standalone tools (e.g., Tableau, Power-BI, Qlik, SpotFire) are specifically designed to produce stunning visualizations while working with multiple platforms. On the other hand, embedded tools (like SSRS, IBM, Oracle, Micro Strategy, and SAP Crystal) are business intelligence and reporting platforms that often incorporate visualization capabilities with broader analytics (Zheng, 2017).

Sri Lanka faces approximately 400 different disaster incidents annually, such as high winds, forest fires, floods, landslides, and epidemics (Desinventar, 2021; Disaster Management Centre, 2016). However, a comprehensive study on these disasters and their mitigation practices is missing. In addition, several weaknesses of current practice need to be fixed for a sustainable solution. Therefore, this research paper presents a comprehensive approach to upgrade the incident reporting process using a freely available software tool, enabling further visualization, and producing a comprehensive timely output to share among stakeholders. Based on the Daily Incident Updates (DIU), a situation report (SITREP) is prepared by the National Emergency Operation Center (N-EOC) of the Disaster Management Centre (DMC) for a particular disaster occurrence or an incident at regular and fixed time intervals. Therefore, a situation report (SITREP) is the base document for initiating communication among the stakeholders and parties to activate their response.

2. Present SITREP practices in Sri Lanka

At the onset of an emergency, Disaster Incident Updates (or Internal Situation Reports) help the headquarters understand the context of the situation and the progress of the response. SITREPs (or External-Sitreps) are one of the main products used by the headquarters with resource mobilization functions to update stakeholders on response to a disaster (IOM, 2023). Ground-level primary data on the disaster incidents are collected by the relevant village administrative officer (commonly recognized as the Grama-Niladhari-GN) and the local Police station. Disaster incidents that occurred at GN and higher levels (Divisional) are reported (by the District Disaster Management Coordination units—DDMCUs) to the N-EOC through a fax message in a unique data-entering Format (refer to **Figure 1**). Those Disaster Incident Updates (DIU) are compiled into a single SITREP by the authorized Duty Officer, of the National-EOC and circulated by 18 h every day, to the different stakeholders and Media agencies. Optimal information sharing and transparency are ensured, once the SITREP is transmitted to operational stakeholders, incident support agencies, and media organizations. In order to manage the incident, and further investigation, SITREP has to be visualized quickly, with more analytical information. Apart from those operational users, SITREPs are widely used by Humanitarian Agencies, Policymakers, and Researchers (CARE International, 2011).

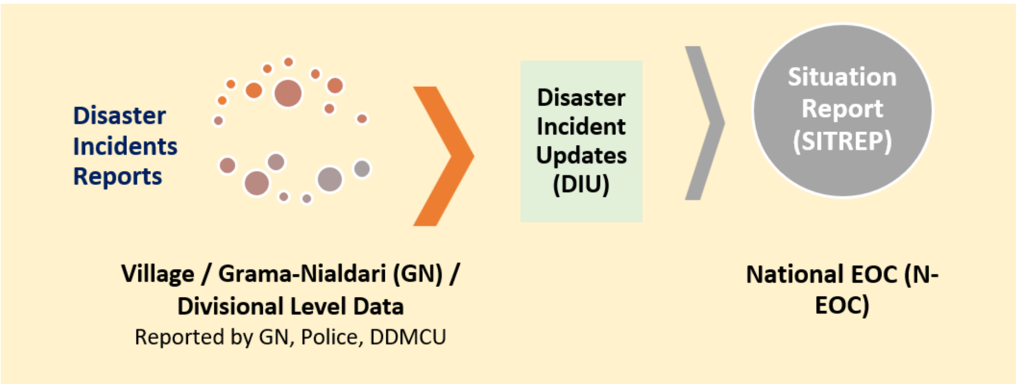

Figure 1. Data collection and reporting process (Incident-Reports, DIUs and SITREP) of the incident from village level to national level.

Usually, the incidents are reported simultaneously in different locations, within several districts. e.g., extreme climate contributed hazards like cyclone, flood, and forest-fire.

Table 1. Three different levels of capacity-based responses on the threshold of the disaster.

Level I	Local agencies, or community-able to contain the incident and respond effectively using their own resources. e.g., small forest fire.
Level II	Require outside assistance (from divisional level up to the provincial level), from nearby Districts and stakeholder authorities. e.g., major flood.
Level III	The disaster is of a magnitude that exceeds the capacity of the province and requires assistance from the national or international level. e.g., tsunami.

Source: Standard Operation Procedures (SOP), Disaster Management Centre-DMC Sri Lanka.

In order to get a real-time update, the SITREP is required to be updated twice or thrice for each operational period (say every 8–12 h) during a quickly evolving emergency or intense situation (Bigley and Roberts, 2001). SITREP has to be revised as time progresses. The dispatch frequency (e.g., every 8 h, 3 dispatches per day, when operational periods are short) is decided at the outset of the emergency and followed in the first three weeks of the emergency. When the emergency situation gradually stabilizes and the situation becomes normal, the reporting period is switched to the usual daily (18 h) dispatch time. When the situation reaches a threshold (e.g., Level II) and exceeds Level II, the National-EOC is mandated to coordinate the Action-Groups to handle the particular disaster incident (refer to **Table 1** and **Figure 1**). Accordingly, to merit special attention, the incident has to be managed by the Incident Management Team (IMT) in place. Then the Situation Unit Leader or Planning Section Chief prepares the comprehensive SITREP of the incident, indicating additional resource support needs and alerting the media about increased public safety threats (Officials' Committee for Domestic and External Security Coordination, 2019). Based on incident support levels, specific guidance is depicted in Standard Operation Procedures (SOPs) from dispatch timelines up to the termination of incident operations. At the initial stage, DIU is to be completed as close to the incident as possible, with the best verifiable information at the DIU completion time. Better visualization of the SITREP facilitates rapid decision-making with more information available.

The National EOC (N-EOC) of the DMC, operating on a 24/7 basis coordinates actions related to all reporting incidents to ensure an effective response process. N-EOC gathers, analyzes, and displays information to enable decision-making on particular incidents. To facilitate this task, a 24/7 Call-Centre (which acts as an instant respondent providing grass-roots levels of disaster information) is coupled with the N-EOC. District EOC (D-EOC) coordinates and responds to local incidents by activating relevant stakeholders through the Standard Operation Procedures (SOPs). The N-EOC assists District-EOCs on request, or if the severity of the disaster is beyond District-EOC's capacity. At the district level, the District Disaster Management Coordinating Unit (DDMCU) and the relevant District Secretary as the chairman of the DDMC Committee, plays a lead response role with District level stakeholders. On the other hand, N-EOC interacts with media for timely dissemination of information to the vulnerable communities and responding agencies, while preparing the SITREP (refer to **Figure 2**).

Visualization of SITREP, at every level operating within a common organizational structure, enables an effective and efficient incident management process by integrating personnel, facilities, equipment, procedures, and communications (Tillekaratne, D. R. I. B. Werellagama, and Prasanna, 2021). In Sri Lanka, "WhatsApp official watch group for the cyclone response" became the first to do so, bringing maximum real-time coordination in response to Cyclonic Storm "Burevi", which made landfall in Sri Lanka in December 2020. Accordingly, such social media platforms help real-time guided visualization of incidents between communities, officials and rescue operators, for efficient coordination, and effective streamlined ground operations reaching the most distant corners of the disaster-affected areas.

3. Materials and methods

Two case studies were conducted to explore the incident situation-reporting process in Sri Lanka. The hierarchy and the chronological order of the reporting process and steps to be taken to improve the process are evaluated in this study. Initiatives taken to incorporate other emergency reporting mechanisms (like in Incident Command Systems—ICS) in the region were also evaluated. Further visualization analysis helped to get speedy, real-time better visual outputs from the initial disaster information and available data layers. Some software tools could help to interpret the SITREP into graphical reports and infographic versions by minimizing the manual analyzing process. It helps quick visualization of the validated ground data at the higher national level using a simple Excel spreadsheet, or a collection of hybrid and cloud-based data warehouses or data sources. It can be easily processed through such software and visualized to share with every authorized user.

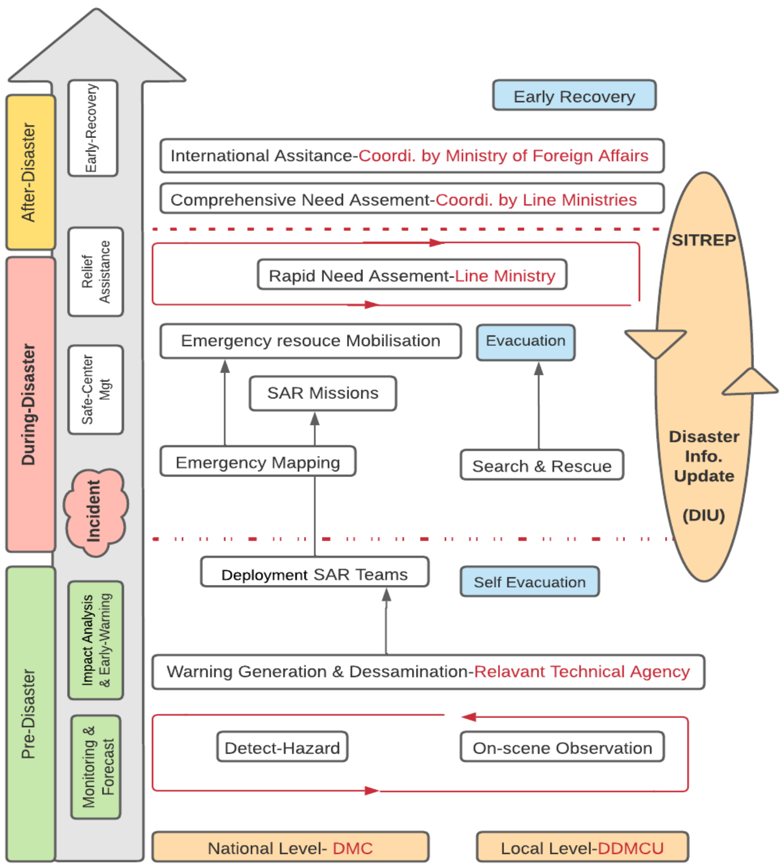

Figure 2. Stages of the response flow, including the deployment of search and rescue (SAR) teams.
Source: Developed further by the authors (DMC, 2017).

The data visualization process covers several sub-phases including data gathering, cleansing, storage, analysis, presentation, and delivery. The data accessibility was obtained from call and chat channels which were already included in the SITREP. The transformation of raw data into meaningful and useful information outputs enable a more effective, strategic, tactical, and operational decision-making process (Zheng, 2017). Some of the tools like Tableau and Power-BI have satisfied this need by using a visualization-driven approach (Sallam et al., 2017). A freely available application (Power-BI) is selected for the study, which works together to turn unrelated sources of data into coherent, visually engaged, and interactive insights. Power-BI is further used as an operational intelligence platform that has required features, functionality, and quick insights built on a growing set of advanced analytical algorithms (Hlavac and Stefanovic, 2020; Jain et al., 2022; Microsoft, 2017; Nagy and Tick, 2017).

Microsoft Power-BI consists of user-friendly advanced analytics to effectively communicate and address operational challenges with more than 20 built-in visuals and a gallery of live visualizations. With the uploading of a dataset and based on the analysis process, several reports are automatically produced via the Power-BI tool. Power-BI is an easy-to-use platform for basic analysis to generate a user-guided report through an Excel spreadsheet or a Google sheet input. The National-EOC, internally analyzed the SITREP through Power-BI, which resulted in a visual dashboard output, which is shared with various action groups for further interaction. This paper reviewed the steps of the process that are in use at present (2023) based on data analysis output. Among the multiple disaster incidents in Sri Lanka in the recent past, extreme weather and climate related disaster incidents were selected (and compared with the output and visualization methodologies currently used) to identify the improvement of the visualization system. A critical review has been made and solutions are proposed to overcome the identified weaknesses. Also, an attempt has been made to show how easily a dataset of different disaster incidents in a single SITREP (e.g., SITREP published on 20 June 2016—refer to **Table A1**) can be transformed through Power-BI into a set of analytical reports and dashboards (as mentioned in **Figure 3**).

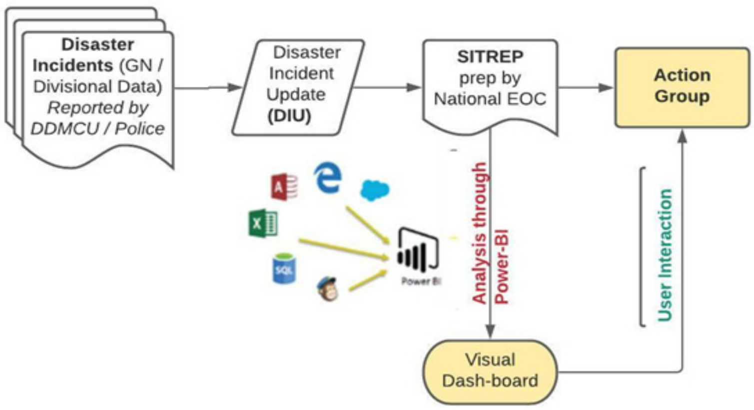

Figure 3. Conceptual diagram of the data sheet converted into a detailed visualized report.

4. Results and discussion

4.1. Hazards

Two different hazard categories reported in the SITREP of the DMC (on 20 June 2016) were utilized to show the ability to combine various disaster incidents in one SITREP. Extreme climatic, hydro-meteorological (flood, landslide, high-wind, etc.) disaster (Case-I) and an explosion (Case-II, as comparatively highly evolving) incident are visualized together (refer to **Table 2**) (Zubair et al., 2011). The details are briefly given below.

CASE-I floods and landslides: Seasonal floods caused by the monsoon rains are a common feature in Sri Lanka. The Cyclonic Storm "Roanu" was a relatively weak tropical cyclone that brought extreme rainfall, causing severe flooding in Sri Lanka and Bangladesh and brought torrential rainfall to the Indian states of Tamil Nadu, Andhra Pradesh, Kerala, and Odisha in May 2016. It was the first tropical cyclone of the annual cyclone season (Kundzewicz, 2016). "Roanu" resulted in widespread floods and landslides in 19 administrative districts, (out of 25) in Sri Lanka, damaging homes and submerging villages in a few river basins (DMC, 2016), as shown in **Figure 4**. Out of total 280,353 affected persons, less than 100 were affected in six districts (Ampara, Monaragala, Badulla, Anuradhapura, Polonnaruwa, and Jaffna).

CASE-II explosion of armory: The extreme weather event in Case-I caused different disaster incidents. An explosion of the armory occurred (at the Salawa Army Camp in Kosgama) at around 5:30 p.m. on Sunday (5 June 2016) and continued until the next day (6 June 2016) morning.

Table 2. Systematic incident reporting and data visualization (data exploration, analysis, decision-making) in two different cases; based on three chronological stages (pre, during and after) of a disaster incident.

Matter	Chronological stage of the incident		
	Pre-incident	During	After
Incident visualization	No incident report. Having a general idea on the impact area and the vulnerable community.	Activates the incident reporting process.	Issuance of periodic incident reports
CASE-I floods and landslides	Early warning issued by the EOC.	Search and rescue teams are deployed.	Relief activities
CASE-II ammunition-dump explosion—Salawa Army Camp	Initial control measures, taken by the Army camp.	External support coordination and immediate evacuation of the surrounding community by the DMC.	Relief activities
How to help visual tools in disaster risk management	• Data visualization through metrics, charts, diagrams, dashboards popups. Vulnerable population (through GN Database). • Information visualization through communication, storytelling, infographics, illustrational diagrams. • Illustration (making the complexity easier to understand) through: processes, structures concepts, diagrams, images and graphics. • Simulation to demonstrate the effect of scenarios under given condition based on models and animated diagrams or virtual reality.		

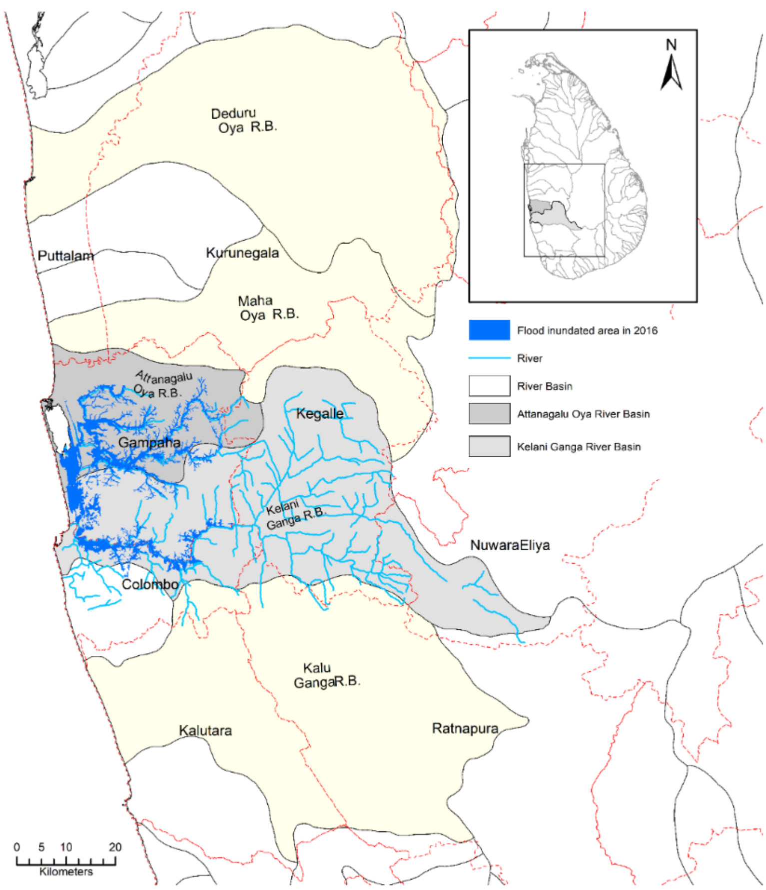

Figure 4. Flood inundated area in Attanagalu-Oya and Kelani River-Basins, (which belong to two provinces (Western and Sabaragamuwa)), May 2016 (Tillekaratne, I. Werellagama, et al., 2021). Building layers of those two provinces were overlapped to identify all vulnerable communities.

Villagers fled or were evacuated by the Army, up to a radius of 6 km from the site of the explosion. Refer to **Figure 5**. A 1 km radius around the Salawa Army Camp has been declared unsafe and the affected area was 8 km radius from the origin. About 7700 people were relocated to safer areas.

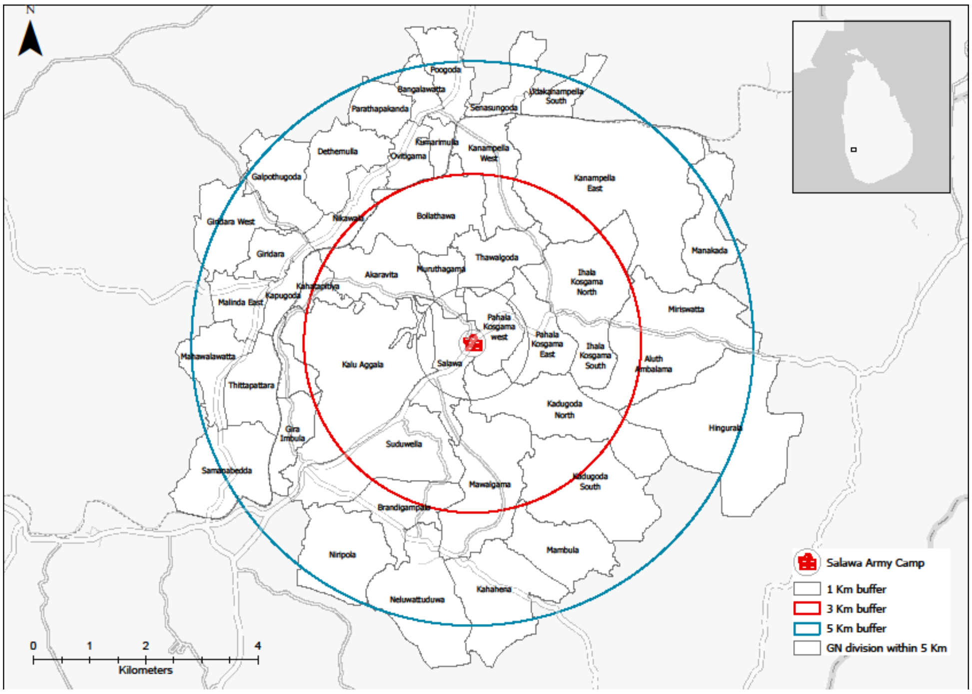

Figure 5. Risk-Circle of the blast. (Exploded artillery shells were spread through the area and easy to zone in a map).

The building layer was overlaid with the risk-circle to trace the vulnerable families in three (further differentiated as high, medium and low) risk-circles. Response time is very critical in emergency operations as more trapped time leads to more death and casualties. Considering the Golden-Hour Principle, search and rescue (SAR) technicians should act within 8–12 min to rescue the critically injured. Communicating with more visualized information such as live videos, photos, and locations, helped SAR-Committee to facilitate the operational team at the ground (Tillekaratne, D. R. I. B. Werellagama, and Prasanna, 2021).

4.2. Data analysis and visualization

The data input responsibility lies with the EOC duty officer and data entry operator of the day. The basic analysis could be pre-worked out on the Power-BI desktop and create a dashboard with appropriate visualizations such as a map, bar chart, pie chart, and table. When the incident lasts over time, it could be indicated as a trending curve (refer to **Figures A1** and **A2**). The dashboard displays visual-oriented most important data and information arranged on a single screen. Accordingly, the consolidated information needed to achieve operational objectives is to be viewed at a glance.

4.3. Creating a dashboard

Figures A1 and **A2** show a partial view of the dashboard, which was created using all the contents given in the situation report (20 June 2016). On each view listing, the insights contents were shown (visualized) in rectangles called tiles, which have a pin–icon, on each reported location of the incidents. All the records were selected, giving the option to pin the contents to an existing or new dashboard. For the first visualization, select a new option with a given incident name for a new dashboard output. For the other visualizations, select the existing dashboard option and embed it as an HTML code/link on the organizational (DMC) website. All this was achieved within 15–20 min without any coding or prior experience, demonstrating how easy it is to publish a particular set of data, with a quick analysis output using software such as Power-BI. Results of further analysis of the data (affected people for each hazard) are also visualized through the dashboard. Without installing the software, users/stakeholders can visualize the output. However, for further editing purposes, Power-BI has to be installed, by the authorized editors.

The dashboard appears to primarily focus on data visualization of disaster situation reporting, including the number of impacted individuals in a nationwide map. The information shown in the dashboard is useful for decision-making at a higher national level on how responders can manage SAR and relief operations based on that information such as deciding the most affected geographic area to deploy SAR teams and critical resources. Further, the visualized dashboard shows the feasibility of responding operations as presented in the two cases, namely the flood and explosion incidents. These are utilized to illustrate how the visualized dashboard can analyze data to provide more valuable scaled down insights than the original situation report. For example, the SAR teams may use live video clips at trapped locations to assess the accessibility of the building for rescue operations, etc.

Multi-hazard mapping has some limitations, particularly with the level of available exposure and vulnerability layers/data and there are multiple ways to weigh the different hazards (Tillekaratne, S. I. S. Subasinghe, et al., 2021). For the accurate visualization output process, pre-arranged data on exposure and vulnerability should be available for each hazard. Daily Incident Updates (DIU) are mainly focused to collect data on deaths, missing-people, affected people, house and building damages, and the number of safety-centers (refugees). Usually, the severity of the disaster and its duration are depicted by the number of people in the safety-centers. Delays in incident reporting were observed, due to various reasons, such as the problem of validation, and misreporting. On such occasions, the date of the disaster does not tally with the reporting date of the SITREP. Therefore, every single incident is kept recorded in the SITREP for a period of one week, as it goes to the open-source Desinventar database of the DMC (Desinventar, 2023).

DIU data is fed into the Central Disaster Information database (Desinventar) managed by the DMC. The Desinventar system facilitates multi-user, remote data entry, data querying, analysis and reporting. Desinventar is a methodological tool for the construction of a central disaster information database of damages and losses with more visualization and analytical ability (Desinventar, 2021). Such Disaster Loss Databases (DLDB's) are essential for countries to report on Sendai framework targets, especially on the first four targets, (out of seven) which addressed the imperative of reducing disaster impacts and losses. The geographic distribution of the disaster and the spatial pattern of the incidents are not totally explained by the usual tabular SITREP; e.g., when the water level reached a "severe-flood" situation, buffer zones were also inundated. Instead of using various terms like "severe-flood", and "severely affected" in the SITREP, it is recommended to use "exposure-index" (e.g., Level 9 for severely affected), for the flood visualization in a particular geographic area. Accordingly, the affected communities are to be considered as the indicator of the flood intensity via categorization number (refer to **Tables 3** and **4**).

Table 3. Disaster (flood) severity index is suggested to be used to standardize flood classification.

Flood-severity level key-parameter	Level-1 Minor	Level-2 Major	Level-3 Severe	Level-4 Enormous
% Affected population in river-basin	<1%	1–5%	5–10%	>10%
% Flooded land area in river-basin	<1%	1–5%	5–10%	>10%
Flood retention period	<12 h	12–36 h	36–72 h	>72 h

Source: Survey Department of Sri Lanka (2016), Tillekaratne, I. Werellagama, et al. (2021) and further developed by the authors.

Table 4. Affected/exposure level index to be used to standardize affected levels. This is based on the score given to four indicators to improve the visualization process.

No.	Affected-indicators	Affected/exposure level		
		Level I	Level II	Level III
1	Indirect losses			
	Access blocked/isolated	1	1	1
	Diseases	1	1	1
	Environmental damage	1	1	1
2	Economic damage			
	Livelihood (crop/livestock damage)	0	1	1
	Business damage	0	1	1
3	Physical damage			
	Non-structural damage to contents	0	1	1
	Structural (house) damaged (fully/partially)	0	0	1
4	Human-social damage			
	Injuries	0	0	1
	Fatalities	0	0	1
	Total	3	6	9

Source: Survey Department of Sri Lanka (2016), Tillekaratne, I. Werellagama, et al. (2021) and further developed by the authors.

Affected people are allocated to different types of support during the incidents, including via social media platform appeals and posts that conveyed concerns, complaints, and gratitude (Young et al., 2020). With the current practice, the affected level cannot be visualized properly. Definitions of the "affected people" are always debatable among the data collectors and reporters. Three key parameters considered to determine the flood severity level are given in **Table 3**. To standardize the visualization process, affected people/families are to be categorized based on the score of the exposure as shown in **Table 4**. Accordingly, the thresholds should be set and validated in a particular geographical (e.g., river basin) area denominating the exact figure of the affected people. Accordingly, it is suggested to use a particular geographical area as the domain of the national level risk management decision-making entity. For the above two hazards (case studies), the raw data of DIU was converted into graphs and charts with the help of visualization tools, based on the above categories to make the response groups for effective communication and operational activities, from the operation center to the field level.

Categorization of flood severity into four levels (**Table 3**) and affected/exposure people into three levels (**Table 4**) are suggested to minimize the confusion among different response agencies. During two monsoonal seasons, about eight river basins are frequently flooded in Sri Lanka. Using **Tables 3** and **4**, flood level and affected level are to be generalized to get a more visualized strategic picture for effective tactical operations.

4.4. Use of Power-BI for SITREP

As most respondents in a disaster situation are from a non-technical background, emergency management authorities should consider the powers of data visualization in delivering digestible insights, by empowering and training the respondents to make data-driven decisions. Analytics tools in Power-BI enable the analysis of data and sharing of insights and visualization through dashboards of the Emergency Operation Rooms. Further, it explores data using intuitive tools to quickly find answers and uncover new insights. The usability of the report increases with the comments and the number of hits using the Google platform. The output report contains the basic information needed to support decision-making at all levels on the incident. Once the incident report is shared with national level decision-makers and others (incident support and coordination points), it is supposed to be transmitted and shared (considering the sensitivity and appropriateness) at local and sub-national levels.

It is recommended that reporting parameters and terminologies of the SITREP, like “affected” and “response level”, be adopted, standardized, and used by all the agencies at all levels, for consistency, incident tracking, documentation efficiency and trend monitoring, etc. Properly defined and standardized terms for each disaster have to be published via Gazette notification to minimize confusion. Automatically added features to the SITREP such as photos and videos of the disaster incident or its aftermath, support decision-making and reporting purposes at every level during the crucial situations. The allocated and committed resources to the incident are unable to respond within the usual timeframe when impacts/threats to life and safety reach a threshold level with a cascade scenario. An example was, COVID-19 Multi-Agency Coordination Task Force in Sri Lanka prepared DIU coupled with the Flood incident, reaching a certain pre-designated higher response level.

When exploring the annual incident calendar, most incidents are of short duration and do not require scarce resources and significant outside attention. To increase accuracy, interoperability and information sharing between diversified systems, it is useful to prepare response reporting indicators (with river-basin-based demarcations for rain-induced disasters) when severe incidents affected large geographic areas/several provinces. Pre-preparedness through mock drills etc., is vital to follow accepted protocols or standards, especially when dealing with location-specific information. To trace the exact location, geospatial information is widely shared to map the accuracy as shown for Case-II, and identify the incident perimeter, point of origin, etc.

4.5. Finding exact disaster location using available communication channels

Based on the vulnerability of the communities, disaster-risk maps are developed covering most parts of the country. However, it is still a challenge to find the exact location of the incident to report to the response teams. The number of SOS calls helps to pinpoint the incident location as mobile phones usually represent an individual, in a particular location. Also, it allows for tracing the spread of disaster through geographic locations and predicting future trends. Disaster information calls make one of the most reliable channels of communication, to be effectively used to drive rescue efforts forward. A relevant recent example (from New Zealand) is the 2023 February cyclone Gabrielle in NZ, where some stranded people could connect to Facebook and live-stream the flood, and their families called rescuers to ask for help (Young et al., 2020). In official Multi-Agency Coordination Systems (MACS), members of national and district agencies and decision-makers such as cooperating and assisting agencies/organizations, dispatch centers, emergency operations centers, administrators, and elected officials, are disseminated the information of the SITREP. A separate bulletin to the SITREP, which contains sensitive information (active investigations, fatalities, etc.) tagged as “restricted” should not be released to the public.

The media play a crucial role and act as a platform and conduit of information during the response and recovery phases of natural disasters. Social media and mobile messaging channels play a vital role in pre and post-disaster management due to their ability to transmit timely and relevant information to a large number of people instantly. According to the experience gained through the “WhatsApp group” in response to the Cyclonic Storm “Burevi” in December 2020, Social Media Chatting System (SMCS) helps to update the DIU and to mobilize relief providers, state organizations, NGOs, private and volunteer groups at the exact affected locations. (Chats instead of calling help many people to communicate simultaneously without congesting the phone lines). The official social media group has to be used to disseminate the visualized SITREP output and link the relevant authorities. Safety checks via social media provided a quick platform for people downstream, whether they were in or out of danger when the upstream water levels reached dangerous flood levels for the incidents in Case-I.

It is recommended to use social media platforms of known stakeholder agencies (the “operational group”) and messenger apps (WhatsApp, Facebook Messenger), chat groups to ensure the reliability of the information received and spreading through social media. Vulnerable communities should be more visualized with potential hazards around them, using social media operational groups for each local GN Level “Risk-channel” when sharing more specific information salient to them. Authorities are yet to officially identify potential social media mobile chat apps as a force to be properly utilized for vulnerable localities.

4.6. Related work in other countries

Even though the situation report visualisation is very new to Sri Lankan context, many countries have successfully used this approach to overcome the damages from disaster incidents (Lillestøl and Rykkja, 2016). Use situation reports to gather information and then to identify the necessary planning arrangements to manage the floods in Norway. A pilot experimental study presented by Tomaszewski et al. (2014) explains the importance of using social media to mitigate the damages from natural disasters like floods. They collected 3.4 million tweets and presented the initial results with their paper. The spatial, temporal, and thematic constraints for disaster situation awareness were well highlighted in their research findings. Hapsari and Zenurianto (2016) have collected flood event data from emergency situation reports to understand the management strategies to mitigate flood damages in Indonesia. They clearly indicated that the prevention and preparedness of the general public are rather low and that makes high damage to the properties and lives of the region. Similar research work can be found in Yang et al. (2012), Arun et al. (2020), and Lam and Chow (2022). Not only for flood events but also for health-related disasters with floods, the situation reports were successfully used. Necessary data were collected from situation reports to understand the health implications of the cholera outbreak in West Africa which are related to recent floods (Sodjinou et al., 2022). A number of similar research works can be found in the literature (Hasleton et al., 2013). Accordingly, situation reports could be used in the Sri Lankan context to understand flood damages togeter with related health implications. Therefore, the research presented in this paper showcases the initial movements which can be used to improve the situation in Sri Lanka for annual floods and flood-related cascade incidents.

5. Conclusions

This paper presented the methodologies currently used to prepare the disaster situation report (SITREP) in a developing country (Sri Lanka). It also showed that the use of free software like Power-BI can be used to improve the quality and timeliness of the situation report, with the AI (in Power-BI) providing a continuously improved, easy to understand visualization of the evolving disaster situation. In addition, the value of available resources like mobile phone communication and the use of social media chats, to get information to update visualizations and to pinpoint disaster locations is emphasized. Usually, dashboard serves to visualize data from the situation report and seems more of a visualization tool at the higher strategic level than the operational level. An example was shown how the same SITREP can overlay the extreme weather incidents (Case-I), and manmade disasters (Case-II), identifying the affected people and improving the contingency plan.

Author contributions

Conceptualization, HIT, IW, PW, TWMTWB and CMMB; methodology, HIT and IW; software, AB; validation, HIT, AB and UR; formal analysis, HIT and AB; investigation, HIT and IW; resources, HIT, IW, CMMB, TWMTWB and AA; data curation, HIT, CS and IW; writing—original draft preparation, HIT; writing—review and editing, IW, UR and AA; visualization, HIT; supervision, IW, CMMB and TWMTWB; project administration, IW and UR. All authors have read and agreed to the published version of the manuscript.

Data availability statement

Data can be requested for research purposes from the corresponding author.

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Conflicts of interest

The authors declare no conflict of interest.

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Appendix

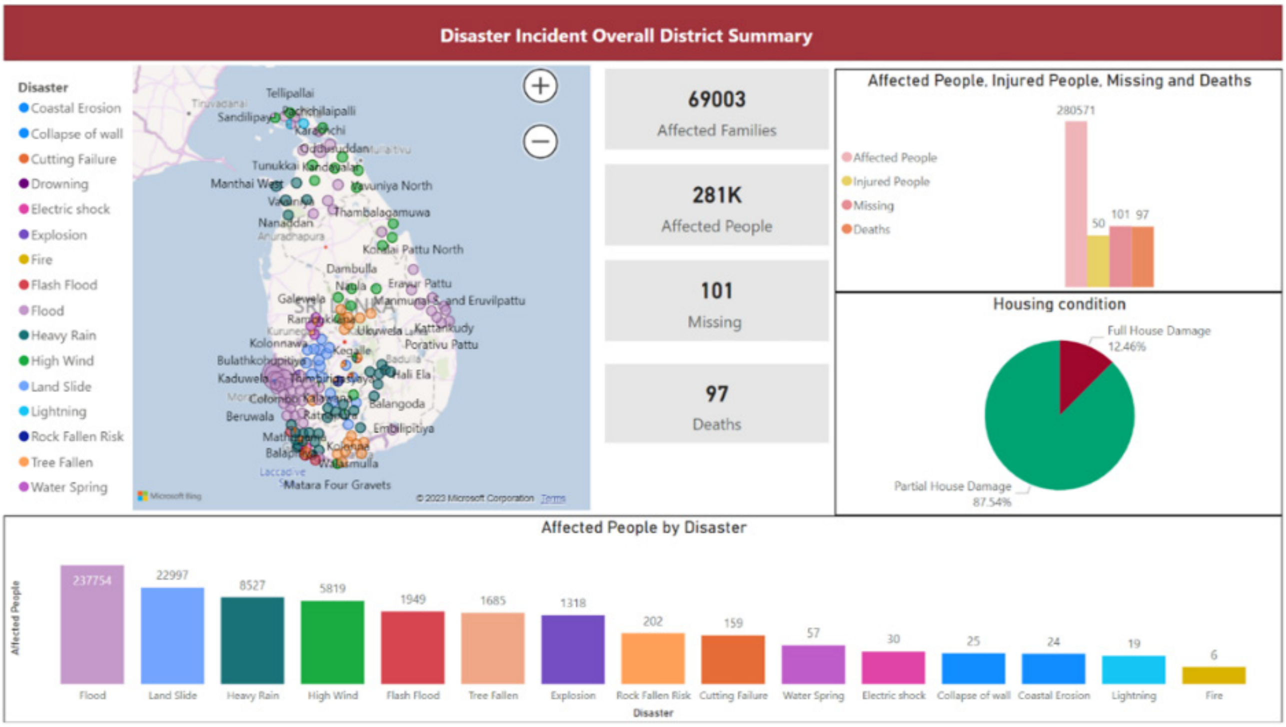

Figure A1. Final visualization dashboard. Overall district wise incident summary prepared using Power-BI worksheet and graphs.

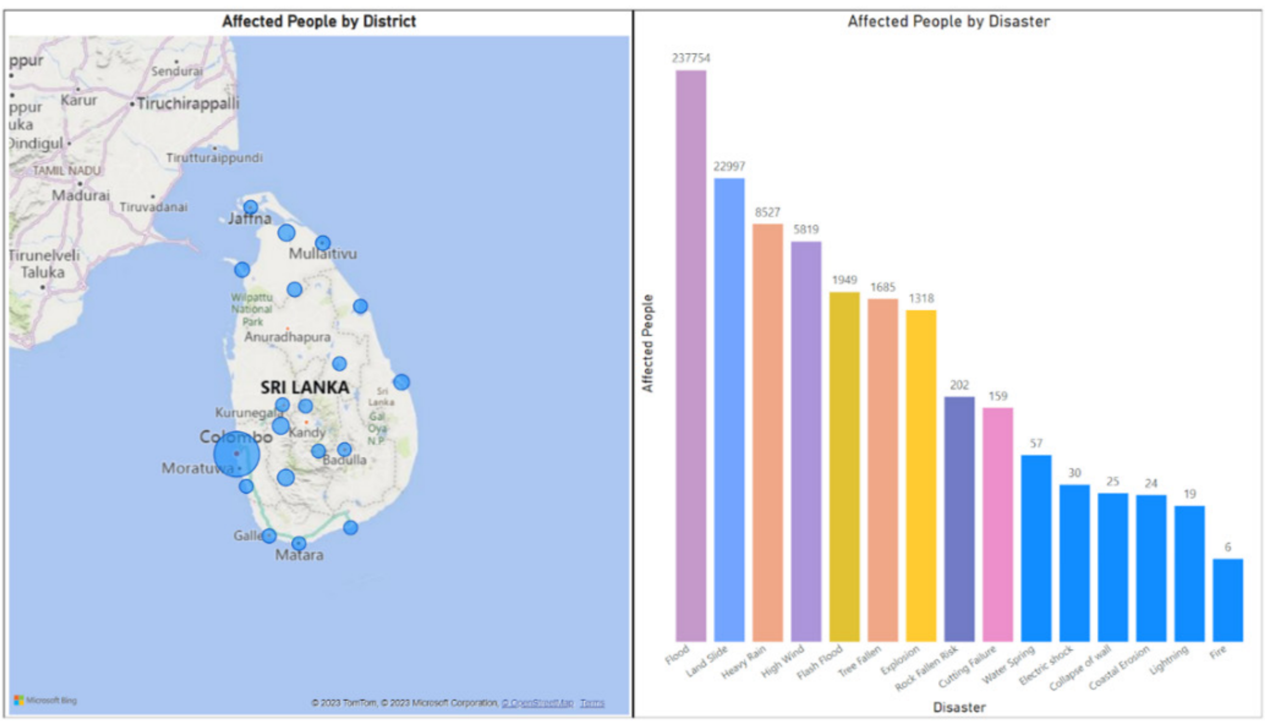

Figure A2. Deep analysis of the data (affected people on each hazard) visualizes through the dashboard.

Table A1. Situation report (20 June 2016) currently use by the EOC, for daily incident updates.

#	District	Disaster	Date	Affected		Deaths	Injured	Missing	Hou damaged		Safe location		
				Families	People				Full	Partial	Nos	Fami	Pers
1	Colombo	Flood	2016.05.15	43,321	190,341	7			28	105	1	40	188
		Drowning	2016.05.22			1							
		Collapse of a wall/heavy rain	2016.05.31			1			1	5			
		Explosion	2016.06.05	351	1318	1					4	78	232
		Coastal erosion	2016.06.04	6	24				5	3	1	6	24
		District total		43,678	191,683	10	0	0	34	113	6	124	444
2	Kalutara	Heavy rain/landslide cutting failure/flood	2016.05.15/2016.05.28	157	634	2			74	638	1	1	5
3	Gampaha	Heavy rain, high wind	2016.05.16/17/26			8			27	273			
4	Rathnapura	Landslide risk	2016.05.15	708	2963				15	102	3	159	732
		Flood	2016.05.16/23	1180	4957	1			10	56			
		Landslide/cutting-failure/heavy rain	2016.05.15	1166	4606				4	86	1	6	22
			2016.05.15	818	2846				17	98			
		Heavy rain	2016.05.15/16	341	1374		4		18	120			
		Heavy rain/tree fallen	2016.05.15	344	1118		3		2	18			
		High wind	2016.05.16/25	17	71					16			
		District total		4574	17,935	1	7	0	66	496	4	165	754
5	Kegalle	Landslide	2016.05.17	675	1798	31	17	96	110	147	11	595	1671
		Landslide-risk/cutting failure	2016.05.17	3879	14,247	15	2	2	92	1373	11	124	341
		Landslide/cutting failure	2016.05.16	910	3630	4		1	64	190	17	237	897
		District total		5464	19,675	50	19	99	266	1710	39	956	2909
6	Nuwara Eliya	Landslide risk	2016.05.05/20	81	230						2	28	115
		Tree fallen	2016.05.18/20	11	47	1			1	9			
		Flash flood	2016.05.19	1	2								
		Landslide cutting failure	2016.05.17/19/27	14	63					7			
		Wall failure	2016.05.26	4	21					2			
		Rock fall risk		44	202						1	44	202
		Landslide cutting failure		21	92					9			
		Fire	2016.05.21	1	6				1				
		Heavy rain	2015.05.13/15	4	15				1	3			
		Collapse of a wall	2016.05.18/19	1	4					1			
		High wind	2016.06.12/15/16/17	4	12					5			
		District total		186	694	1	0	0	3	36	3	72	317

Table A1. (*Continued*).

#	District	Disaster	Date	Affected		Deaths	Injured	Missing	Hou damaged		Safe location		
				Families	People				Full	Partial	Nos	Fami	Pers
7	Kandy	Landslide risk	2016.05.10/16						1	48	1	23	87
		Heavy rain/landslide cutting failure	2016.05.16			7	3		17	411	6	76	308
		District total		0	0	7	3	0	18	459	7	99	395
8	Matale	Heavy rain, high wind/tree fallen cutting failure	2016.05.15	199	702		3		11	133	1	7	28
9	Galle	Flash flood	2016.05.15/16/28	487	1939				3	17			
		Tree fallen	2016.05.15/17/18	10	32				1	9			
		Lightning	2016.05.22	3	11		1			3			
		Heavy rain	2016.05.15/16	105	400				5	79			
		Flood	2016.05.16	4	25								
		Electric shock	2016.05.16	9	30	1				8			
		Cutting failure	2016.05.29	2	4								
		District total		620	2441	1	1	0	9	116	0	0	0
10	Matara	Tree fallen	2016.05.15/16/17/31	4	20	1				5			
		High wind	2016.05.19	9	38					9			
		Fire	2016.05.25						1				
		District total		13	58	1	0	0	1	14	0	0	0
11	Hambantota	Tree fallen	2016.05.15	30	133				2	28			
		Flood	2016.05.14	1	5					1			
		District total		31	138	0	0	0	2	29	0	0	0
12	Anuradapura	Heavy rain	2016.05.17			2			5	17			
13	Polonnaruwa	Heavy rain, high wind	2016.05.16	1	4								
14	Puttalam	Heavy rain, high wind	2016.05.17/18			4	6		71	311			
15	Kurunegala	Water spring	2016.06.05/06/07	17	57				5	14			
		Tree fallen	2016.06.07	6	21					6			
		Flood				5			22	52			
		District total		23	78	5	0	0	27	72	0	0	0
16	Vavuniya	Flood	2016.05.16	1376	5078				32	103			
		High wind	2016.05.18	1	6					1			
		District total		1377	5084	0	0	0	32	104	0	0	0
17	Mannar	Heavy rain	2016.05.16	1885	6627				23	80			
18	Jaffna	Drowning	2016.06.20	2	11	3							

Table A1. (*Continued*).

#	District	Disaster	Date	Affected		Deaths	Injured	Missing	Hou damaged		Safe location		
				Families	People				Full	Partial	Nos	Fami	Pers
19	Mulaitivu	Heavy rain/high wind	2016.06.08	1997	5199				23	188			
20	Killinochchi	Flood	2016.05.16	5467	18,265		3		16	251			
21	Trincomalee	High wind	2016.05.23/24	12	41				1	7			
		Flash flood		47	169					6			
		District total		59	210	0	0	0	1	13	0	0	0
22	Batticaloa	Flash flood	2016.05.23	3172	10,748	0	0	0	10	5	0	0	0
23	Ampara	High wind	2016.05.27							3			
24	Badulla	Heavy rain	2016.05.14	47	167	0	0	0	3	44	0	0	0
25	Moneragala	Drowning	2016.06.01	0	0	1	0	0	0	0	0	0	0
Sri Lanka total				68,952	280,353	96	42	99	722	5105	61	1424	4852

Source: Disaster Management Centre (2016). Situation report—Sri Lanka, Date: 20 June 2016 at 1800 h.